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Description of a Stationary Drop-net for Estimating Nekton Abundance in Shallow Waters¹

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ABSTRACT

A 4 m² stationary drop-net capable of sampling the entire column of water in depths up to 1 m is described. The net is a modified purse seine constructed of 3-mm nylon mesh with top enclosed and hung from a frame 1 m above the surface. The net is dropped when support pins are released via a trip line from the shore. In 25 paired trials, the haul seine, with its greater area of coverage per haul (525 m²), captured more species than the drop-net, but the drop-net yielded estimates of a significantly higher density for fish and macrocrustaceans by individual species.

Problems associated with the lack of adequate gear for quantitative sampling of fishes and other aquatic organisms have plagued researchers for years. Most fishing gears are selective for specific organisms or size ranges, and the use of multiple gears does not resolve sampling problems unless the gears can be cross-calibrated. Recent developments from stationary drop-net quadrats (Hellier 1958, 1962), helicopter borne purse nets (Jones et al. 1963; Jones 1965) and portable drop-nets (Moseley and Copeland 1969) have improved the possibility of obtaining representative nekton samples in shallow waters.

In this paper we described a stationary drop-net that was developed to obtain estimates of nekton abundance in estuarine waters less than 1 m deep. Evaluation of the drop-net included assessment of its mechanical operation under varied environmental conditions and comparison of the estimates of fish and macrocrustacean densities based on standard haul-seine catches to those gained from drop-netting.

DROP-NET DESCRIPTION

The 2 × 2 × 1-m drop-net is constructed of 3 mm nylon mesh and is enclosed on all four sides and the top (Fig. 1); a height of 1 m

allows the 4 m² net to fish effectively to that depth. The net is suspended from a stationary 2 × 2-m frame by pins inserted through two eyebolts attached to each corner of the frame and through two support rings attached at each corner of the net. Lines from each of the four pins meet at a common point where they are connected to a 25-m trip line which is pulled manually. The trip line is held above the water prior to each drop to prevent disturbance of the water surface. The drop-net also may be operated from a boat or by remote control.

A chain (0.6 kg/m) secured to the bottom edge causes the net to drop rapidly and aids in preventing escapement of organisms once the net has reached bottom. Plastic floats on the upper edge keep the net spread in the water. The net is closed when the bottom is pursued through rings attached to the chain line. To keep the net on the bottom during pursuing the purse line is drawn under the sampler's foot. To allow for disturbance caused by hanging the net, we used a standard waiting period of 10 min between hanging and releasing the net. The entire operation of hanging, releasing and pursuing the drop-net can be performed by one man in 15–20 min, including the standard 10 min waiting period.

RESULTS

The drop-net's mechanical operation was successful under most of the environmental

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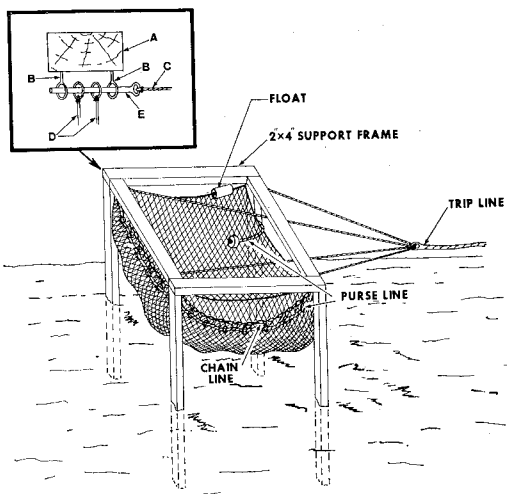


FIGURE 1.—Stationary drop-net on frame in the pre-drop position. Insert shows the details of net attachment to frame. A. Top, horizontal, edge of frame. B. Eye bolt, permanently attached to frame. C. Nylon line to trip line. D. Line and support rings, one of the two lines attached to a top corner of net, the other to a bottom corner of net. E. Pin, pulled to release net.

conditions present during a year-long sampling program conducted at six sampling stations in the Newport River estuary, Carteret County, North Carolina. A total of 20 species of fish, and 4 species of crustaceans representing several size classes were collected. The drop-net catches contained both pelagic and demersal forms and suggested that the net sampled the entire water column. Muddy areas had proved physically impossible to sample with a standard haul seine, whereas the sites were successfully sampled with the drop-net. High wind affected the drop-net performance by collapsing the net as it dropped, thus decreasing the area sampled. Decreasing the height of the net above the water may lessen this problem, but may increase the chance of fish being attracted to or avoiding the net due to the net's shadow. The drop-net frame itself also may attract or repel organisms, as noted by Kjelson and Johnson (in press) in their evaluation of a 16 m² portable drop-net. Water currents may prevent the net from dropping vertically and covering the 4 m² area, although the heavy chain line used on our net appeared to eliminate this potential problem. The stationary

drop-net is essentially limited to shallow waters of less than 1 m in depth with sufficient wave or tidal action to allow the substrate to recover between series of drops. Dropping in depths greater than 1 m would increase the time for the net to reach the bottom and thus allow increased escapement, particularly in nonturbid waters.

Routine sampling over the year-long period showed considerable between-sample variation. On each sampling date, nets were hung on three frames at each station and dropped in rapid succession. The procedure was repeated following the 10 min waiting period to attain a total of six drops. Coefficients of variation (100 SD/mean number caught per drop) for six typical drops varied with respect to the species involved: Bay anchovy, *Anchoa mitchilli*, 159%, a schooling fish; Atlantic croaker, *Micropogon undulatus*, 95%, a semidemersal fish; hogchocker, *Trinectes maculatus*, 178%, a demersal fish; blue crab, *Callinectes sapidus*, 145%, and white shrimp, *Penaeus setiferus*, 101%, both demersal crustaceans. Such variation, with the standard deviation equal to or greater than the mean, indicates the clumped distribution typical of fish and macrocrustaceans. This variability also suggests that a considerable number of drop-net samples are required to estimate the abundance of these aquatic organisms. The total mean number of fish and crustaceans collected during the first series of three drops ($\bar{x} = 13.3$, SD = 28.2, $n = 40$) did not differ significantly from those collected during the second series of three drops ($\bar{x} = 11.2$, SD = 27.2, $n = 40$). We believe that the standard waiting period of 10 minutes between each series was sufficient to overcome the disturbance caused by hanging the net.

Concurrent sampling by haul seine and drop-net also was used to evaluate the drop-net. These trials were to determine if organisms could avoid capture by the haul seine to a greater degree than they could by the drop-net, and thus to provide some assessment of the drop-net as a potential sampling device useful in estimating densities of organisms in shallow waters.

Twenty-five paired daylight trials were made between 10 June and 22 July 1971. A 4 m² drop-net was installed over a gently slop-

ing sandy bottom approximately 25 m from the shore. The net was dropped in 1 m of water at high slack tide. At the same time a sweep was made with a standard haul seine in an adjacent area of similar depth and bottom type. The haul seine measured 1.2×21.3 m, and had a 2.3 m^2 center bag and lead line (0.1 kg/m). The wings were 5.4 mm and the bag was 3.2 mm (bar measure) woven nylon mesh. The seine was pivoted in a 18.3 m radius around a point on the shoreline and each sweep covered an area of 525 m^2 . Data were converted to numbers per 1000 m^2 for each abundant species. A Wilcoxon test for paired values (Alder and Roessler 1964) was used to determine if the drop-net catches (in terms of numbers/ 1000 m^2) were significantly different from those in the haul seine; the test also was used to determine if there was a significant difference in the number of species collected by the two gears. Geometric means of the catches were compared to determine which gear provided the greater estimate of each population's density.

A total of fifteen species of fishes, and the blue crab, *Callinectes sapidus*, were taken during the 25 paired gear trials. Nine of the 16 species were in the drop-net samples, while 15 occurred in the haul-seine samples. There was a significant difference at the 99% level between the number of species collected per sample with the two gears, with the haul seine consistently collecting the greater number of species. This was expected since the haul seine sampled 525 m^2 per sample versus 4 m^2 by the drop-net.

Although a total of 15 species of fishes representing a variety of ecological groups (pelagic, semi-demersal and demersal), were collected, only three (pinfish, *Lagodon rhomboides*; spot, *Leiostomus xanthurus* and blue crab) juveniles were judged numerous enough to be used in the analysis. Little difference was observed in the mean sizes of fish and blue crabs caught by the two gears.

There were significant differences in density estimates based on haul-seine and drop-net catches of spot and total fish. However, estimates of pinfish and blue crabs by the two gears were not significantly different (Table 1). Catch data were transformed to

TABLE 1.—Catch statistics from 25 haul seine and stationary drop-net paired trials

Taxa (Mean size mm)	Probability values ^a	Modified geometric means (numbers/ 1000 m^2)	
		Drop-net	Haul seine
Spot (63)	0.01	10.52	5.73
Pinfish (90)	0.58	5.86	8.38
Blue Crab (89)	0.21	4.05	2.82
All species combined	0.0002	67.1	30.1

^a Probability of mean catches of the two gears being equal based upon Wilcoxon test for paired values (Alder and Roessler, 1964).

the form $X_i + 1$, with X_i being the number per square meter for each species or a total of all species, estimated from each drop. A modified geometric mean was calculated from the transformed data. Geometric means are less affected than are arithmetic means by a few large estimates of population density often present in drop-net samples. In addition, a geometric mean is more appropriate since it approximates the median, whereas the arithmetic mean may not. For comparison, the modified geometric means, as estimates of population density, were used to provide measures of the differences in the ability of the drop-net and haul seine to assess fish and macrocrustacean densities.

These geometric means (Table 1) combined with the probability values indicated that the drop-net provides a higher estimate of spot density by a factor of 2:1 and also a higher estimate of the density of all species combined again by a factor 2:1. It is possible that estuarine fish and macrocrustaceans more effectively avoid capture by the haul seine than by the drop-net due to the differences in time required to sample with the two gears. The drop-net surrounds 4 m^2 almost instantaneously, whereas the haul-seine sample, although greater in size, takes from 1–2 minutes. Thus, fish and macrocrustaceans may swim away from the path of the seine. In addition, since crabs and shrimp may burrow into the substrate, the haul-seine lead line may pass over them. The drop-net, however, with its pursuing operation and heavy chain line that digs into the substrate may assure more efficient collection.

Preliminary evaluation of the stationary drop-net indicates that, with limitations, it is

a feasible method to sample estuarine nekton in depths less than 1 m. Many of the advantages and disadvantages discussed by Moseley and Copeland (1969) concerning their portable drop-net are applicable in discussing the value of our stationary drop-net. The stationary drop-net enables samples to be taken in muddy areas and at selected locations within waters that contain obstructions, such as tree branches and logs. Our evaluation provides some direct evidence that the stationary drop-net provides estimates of fish and macrocrustacean abundance that are equal to or greater than those of a standard haul seine, and suggest that the drop-net estimates of density are, at least for some species, more representative.

Although our efforts to compare drop-net and haul-seine estimates of fish and crustacean density are limited, the need for such an approach has been strongly emphasized by Allen, DeLacy, and Gotshall (1960) and Watt (1968). Such comparative gear research is necessary for evaluating new sampling techniques and improving our capability to estimate fish populations.

The major limitations of the stationary drop-net are the small sample size, small number of samples per unit time, depth limitations, and the bias created when organisms avoid or are attracted to the net or frame. The small sample size (4 m²) is limiting particularly for fish of lesser abundance and those with a clumped distribution.

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